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The Burden of Cancer in the Elderly

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INTRODUCTION

In 2005, it was estimated that a total of 1,372,910 new cases of invasive cancer would be diagnosed in the United States (1); this estimate does not include the more than 1,000,000 cases of basal and squamous cell skin cancer. The majority of these cancers occur at three sites. In men, over 55% of new cases are due to cancers of the prostate (33%), lung and bronchus (13%), and colon and rectum (10%). In women, 55% of new cases are due to cancers of the breast (32%), lung and bronchus (12%), and colon and rectum (11%).

TRENDS IN CANCER

Between 1978 and 2002, the incidence rate in men rose 13% for all cancers combined and 77% for prostate cancer, while declining 20% for lung cancer (2). Among women, the incidence rate increased 15% for all cancers combined, 71% for lung cancer, and 32% for breast cancer. The colorectal cancer incidence rate declined by 17% for both sexes during this period. The risk of developing most cancers increases with advancing age. More than half of all new cancers in 2002 occurred in the population aged 65 years and older. This proportion will increase, due, in large part, to the impact of the baby boom generation, and the burden of cancer will increase as more people live longer.

In the United States, cancer is the second most frequent cause of death, accounting in 2002 for more than 550,000 deaths (23%) and following only deaths due to heart diseases (Table 1) (3). Cancer was the second most frequent cause of death among both males and females overall and at ages 65 to 84. Cancer was the leading cause of death among women aged 20 to 64 and men aged 45 to 64. The most frequent cause of death due to cancer at all ages combined was lung cancer, followed by prostate cancer among males and breast cancer among females, with colorectal cancer the third and pancreatic cancer the fourth among both sexes (Table 2). These patterns are apparent at ages 65 to 84. However, among older males, prostate cancer ranked first, followed by lung, colorectal, and bladder cancers. Among older

Table 1 Reported Deaths for the Five Leading Causes of Death by Age and Sex, United States, 2002

	All ages		Ages 0–19		Ages 20–44		Ages 45–64		Ages 65–84		Ages 85+	
Rank	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
	All causes: 1,198,982	All causes: 1,244,048	All causes: 32,565	All causes: 21,289	All causes: 100,901	All causes: 50,828	All causes: 259,085	All causes: 166,642	All causes: 580,525	All causes: 550,119	All causes: 225,966	All causes: 455,170
1	Heart diseases: 340,899	Heart diseases: 356,001	Accidents: 8,271	Perinatal conditions: 6,188	Accidents: 28,104	Cancer: 11,448	Cancer: 76,307	Cancer: 66,721	Heart diseases: 175,875	Heart diseases: 150,253	Heart diseases: 80,935	Heart diseases: 169,238
2	Cancer: 288,763	Cancer: 268,501	Perinatal conditions: 8,028	Accidents: 4,171	Heart diseases: 12,180	Accidents: 9,450	Heart diseases: 71,139	Heart diseases: 30,665	Cancer: 167,037	Cancer: 144,782	Cancer: 34,621	Cerebrovascular diseases: 48,096
3	Accidents: 69,183	Cerebrovascular diseases: 100,048	Congenital anomalies: 3,585	Congenital anomalies: 3,233	Suicide: 11,592	Heart diseases: 5,290	Accidents: 16,273	Cerebrovascular diseases: 7,218	Chronic obstructive pulmonary diseases: 39,771	Cerebrovascular diseases: 43,019	Cerebrovascular diseases: 18,316	Cancer: 44,561
4	Cerebrovascular diseases: 62,621	Chronic obstructive pulmonary diseases: 64,101	Homicide: 2,225	Cancer: 989	Cancer: 9,516	Suicide: 2,802	Liver diseases: 9,513	Chronic obstructive pulmonary diseases: 7,177	Cerebrovascular diseases: 33,862	Chronic obstructive pulmonary diseases: 39,258	Chronic obstructive pulmonary diseases: 12,436	Alzheimer's disease: 26,602
5	Chronic obstructive pulmonary diseases: 60,708	Diabetes mellitus: 38,948	Suicide: 1,479	Homicide: 776	Homicide: 9,193	HIV infection: 2,225	Diabetes mellitus: 8,908	Accidents: 6,747	Diabetes mellitus: 18,712	Diabetes mellitus: 21,279	Pneumonia and influenza: 11,199	Pneumonia and influenza: 20,796

Source: From Ref. 3.

Table 2 Reported Deaths for the Five Leading Cancers by Age and Sex, United States, 2002

	Age					
Rank	All ages	0–19	20–44	45–64	65–84	85+
Males	All cancers: 288,763	All cancers: 1,282	All cancers: 9,516	All cancers: 76,307	All cancers: 167,037	All cancers: 34,621
1	Lung and bronchus: 90,121	Leukemia: 382	Lung and bronchus: 1,488	Lung and bronchus: 25,588	Lung and bronchus: 56,340	Prostate: 8,957
2	Prostate: 30,446	Brain and ONS: 327	Colon and rectum: 964	Colon and rectum: 7,537	Prostate: 19,053	Lung and bronchus: 6,699
3	Colon and rectum: 28,471	Endocrine system: 104	Brain and ONS: 912	Pancreas: 4,538	Colon and rectum: 16,124	Colon and rectum: 3,838
4	Pancreas: 14,876	Bones and joints: 96	Leukemia: 850	Esophagus: 3,506	Pancreas: 8,540	Bladder: 1,791
5	Leukemia: 12,058	Soft tissue: 82	Non-Hodgkin's lymphoma: 679	Liver and IHBD: 3,469	Leukemia: 6,833	Leukemia: 1,597
Females	All cancers: 268,501	All cancers: 989	All cancers: 11,448	All cancers: 66,721	All cancers: 144,782	All cancers: 44,561
1	Lung and bronchus: 67,509	Leukemia: 296	Breast: 3,141	Lung and bronchus: 17,215	Lung and bronchus: 41,960	Colon and rectum: 7,308
2	Breast: 41,514	Brain and ONS: 244	Lung and bronchus: 1,388	Breast: 14,181	Breast: 18,057	Lung and bronchus: 6,943
3	Colon and rectum: 28,132	Endocrine system: 89	Cervix uteri: 890	Colon and rectum: 5,302	Colon and rectum: 14,771	Breast: 6,134
4	Pancreas: 15,387	Bones and joints: 83	Colon and rectum: 748	Ovary: 4,465	Pancreas: 9,202	Pancreas: 2,937
5	Ovary: 14,682	Soft tissue: 71	Leukemia: 625	Pancreas: 3,000	Ovary: 7,860	Non-Hodgkin's lymphoma: 2,164

Note: All cancer categories exclude basal and squamous cell skin cancers and in situ carcinomas except bladder.
Abbreviations: ONS, other nervous system; IHBD, intrahepatic bile duct.
Source: From Ref. 3.

females, colorectal cancer ranked first, followed by lung, breast, and pancreatic cancers. At young ages, leukemia and brain cancer predominated. Among males aged 20 to 64, the predominant cancers were those of the lung and colorectum. Among females, breast cancers exceeded lung cancer at ages 20 to 44, but the reverse occurred at ages 45 to 64. The number of deaths due to cancer rose from about 2300 among those under the age of 20 to more than 300,000 at ages 65 to 84 years, and to 79,000 at ages 85 and older.

In this chapter, we will draw upon descriptive data available from several sources. Much of the incidence and survival data derive from information regarding primary cancers diagnosed among the residents of areas in the United States participating in the Surveillance, Epidemiology, and End Results (SEER) program supported by contracts awarded by the National Cancer Institute, and population estimates based on data from the Census Bureau (4). Mortality data for the United States were based on death certificate information provided by the National Center for Health Statistics. Data provided by the World Health Organization and compiled by the International Agency for Research on Cancer were used to evaluate the international variation in mortality among the elderly (5).

From 1978 to 2002, the total number of cancer cases, excluding superficial skin cancers, diagnosed in the nine SEER areas rose 72%, and the number of deaths in the United States due to cancer rose 41% (Table 3). These increases were due to several factors. The first is the growth in the population size, which increased about 30%. Thus, the crude incidence rate per 100,000 population rose 33%, and the crude mortality rate increased 9%. Rates for most cancers rise with age. Because mortality owing to other causes, notably cardiovascular disease, has declined, people have been living longer, shifting the age distribution toward older ages. A technique called age adjustment accounts for these changes, permitting the comparing of rates as though the population age distributions were the same. Comparison of the age-adjusted rates, a better reflection of the changes in risk, reveals that the incidence rose by a more modest 16%, and the mortality actually declined by 5%.

The projected number of cancer cases is expected to double over the next 50 years, from 1.3 million in 2000 to 2.6 million in 2050, due to population growth

Table 3 Trends in Total Cancers in the United States, 1978 to 2002, All Ages

	1978	2002	% Change
Incidence[a] in 9 SEER areas			
Number of cases	71,921	123,856	72.2
Population	21,035,770	27,219,888	29.4
Crude incidence rate[b]	341.9	455.0	33.1
Age-adjusted incidence rate[b]	407.2	471.4	15.8
Deaths in the United States			
Number of deaths	395,099	557,264	41.0
Population	222,097,449	287,974,001	29.7
Crude mortality rate[b]	177.9	193.5	8.8
Age-adjusted mortality rate[b]	204.4	193.5	−5.3

[a]Excludes basal and squamous cell skin cancers and in situ carcinomas except bladder.
[b]Per 100,000, age-adjusted using the 2000 U.S. population standard.
Source: From Refs. 2 and 3.

and decline in death rates, even with no changes in the current cancer incidence rates (6). The number of incident cancers among the elderly aged 75 and older are projected to almost triple from 389,000 in 2000 to 1,102,000 in 2050, and the number among those aged 85 and older is expected to increase fourfold. The projected increases in the numbers of cancers among the elderly will be of increasing importance to clinicians, researchers, and health care administrators in planning future cancer care and research interventions, as well as health policies and public health campaigns for the elderly.

The incidence of all cancers combined among elderly males aged 65 to 84 years increased 24%, from 2538 per 100,000 person-years during 1978–1982 to 3157 during 1988–1992, before declining 8% to 2899 during 1998–2002 (Fig. 1). Total cancer mortality rose 5% and then decreased 9% during the same time periods. Among elderly females, both incidence and mortality rates were considerably lower, although continuing to rise, over the entire time period. Total cancer incidence rates increased 21%, from 1408 to 1703, and mortality rates rose 13%, from 720 to 813.

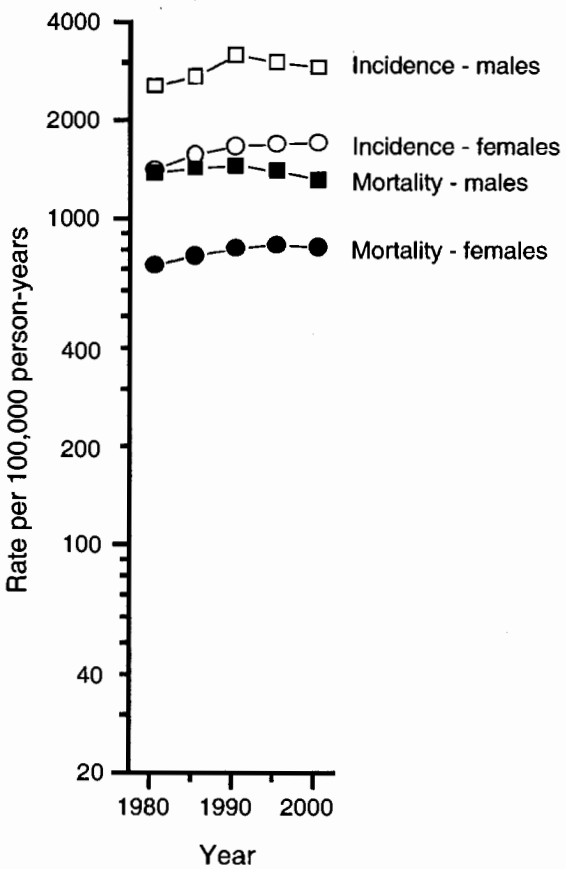

Figure 1 Surveillance, Epidemiology, and End Results (SEER) program incidence in 9 areas and U.S. mortality rates for all cancers combined among the elderly aged 65 to 84 years by sex, 1978–1982 to 1998–2002.

Among elderly males, the rising total cancer incidence rates were driven largely by prostate cancer: rates increased by 78% from the period 1978–1982 to 1988–1992, a period during which many subclinical cases of prostate cancer were diagnosed based on prostate-specific antigen screening along with digital rectal examination (7,8); subsequently, the rates declined 14% by 1998–2002 (Fig. 2A). Lung cancer incidence among elderly males peaked around 1990. This reflects the impact of large declines in prevalence of smoking since 1965, due in large part to successful smoking prevention and cessation public health campaigns (9,10). Colorectal cancer also peaked during the late 1980s; trends varied by subsite, with rates declining for rectal cancer and rising for proximal cancer (11). Rates increased substantially for esophageal and kidney cancers, melanoma, and the lymphomas. The rises in esophageal and kidney cancer incidence are related to smoking and obesity (12–14), whereas increasing melanoma rates are related to ultraviolet radiation and sunburns (15). The rising lymphoma incidence may be related to occupational exposures to pesticides or solvents and to AIDS, particularly among young and middle-aged men; risk also may be associated with diets that are high in animal protein and fat and low in fruits and vegetables (16,17). Rates for stomach cancer have declined, most likely related to reductions in smoking, improved diet, and decreases in the prevalence of *Helicobacter pylori* (12). Decreases in oral cancer rates are also related to declining tobacco use (both cigarette smoking and the use of smokeless tobacco), alcohol consumption, and infection with certain viruses (18). Prostate cancer mortality increases were less dramatic than those for incidence, and the mortality declined notably in recent years. Lung cancer mortality rates also peaked around 1990, and the patterns for the other cancers resembled the incidence trends.

Among elderly females, the most rapid increases in incidence as well as mortality were for lung cancer (Fig. 2B). Lung cancer rates more than doubled from 1978–1982 to 1998–2002, although the rates of increase have diminished in recent years. American women started smoking about 10 years later than American men, and they have not been as successful at quitting (9,19). During the 1980s, the lung cancer mortality rate for women aged 65 to 84 years surpassed both the breast and colorectal cancer mortality rates, and, in the 1990s, lung cancer surpassed colorectal cancer as the second most frequent cancer. Breast cancer incidence rates rose significantly until the 1990s, with a more modest rise in rates since that time; mortality rates have declined 16% since 1990. The rapid increases in the incidence of breast cancer during the 1980s in the United States, and more recently in other countries, were related to mammography screening, although the patterns also reflect disparities in lifestyle and hereditary factors (20,21). As among men, the female rates for melanoma, lymphomas, and kidney cancer also increased substantially, whereas the rates declined notably for stomach and cervix uteri cancers. The declines in the incidence of cervical cancer have been more pronounced for squamous cell carcinomas than adenocarcinomas, at older ages than younger ages, and among blacks than whites (22). The more rapid decreases in mortality than in the incidence rates for corpus uteri cancer are related to improvements in survival, which have varied by race, histologic type, stage, grade, and age group (23). Ovarian cancer incidence trends have differed by histologic type, although improving specificity in pathologic classification probably played a role (24).

The risk of dying from cancer generally increases exponentially with age (Fig. 3). Based on U.S. mortality data for the period 1978–2002, the rates for all cancers combined increased linearly from around the age of 20 to about the age of 60, after which the increases were less rapid. Higher rates among males than females were most evident at the ages of 60 and older. This pattern was repeated for many of the specific forms of cancer, although there were exceptions. For lung cancer, the

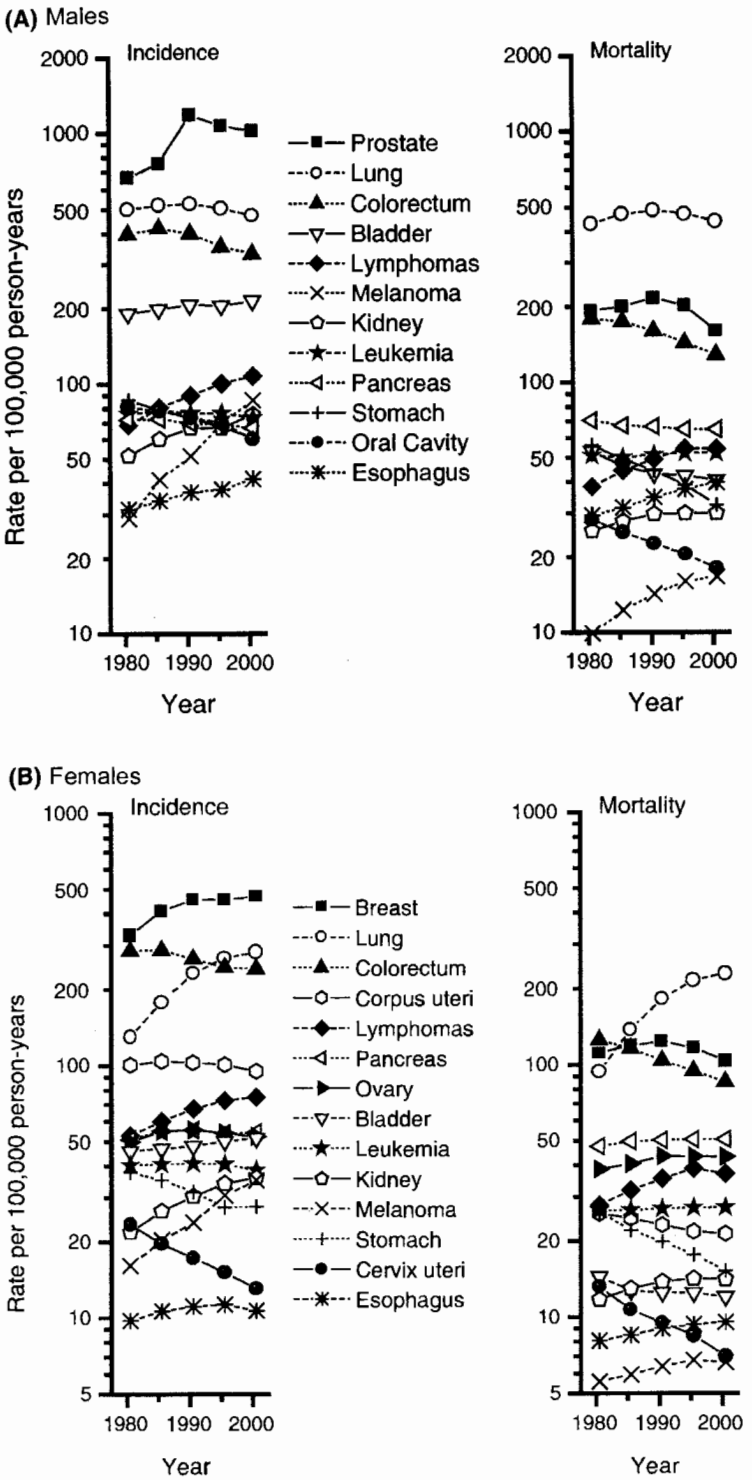

Figure 2 Surveillance, Epidemiology, and End Results (SEER) program incidence in 9 areas and U.S. mortality rates for selected cancers among the elderly aged 65 to 84 years, 1978–1982 to 1998–2002: (**A**) males, (**B**) females. *Note*: Lymphomas include Hodgkin's and non-Hodgkin's lymphoma; oral cavity includes pharynx.

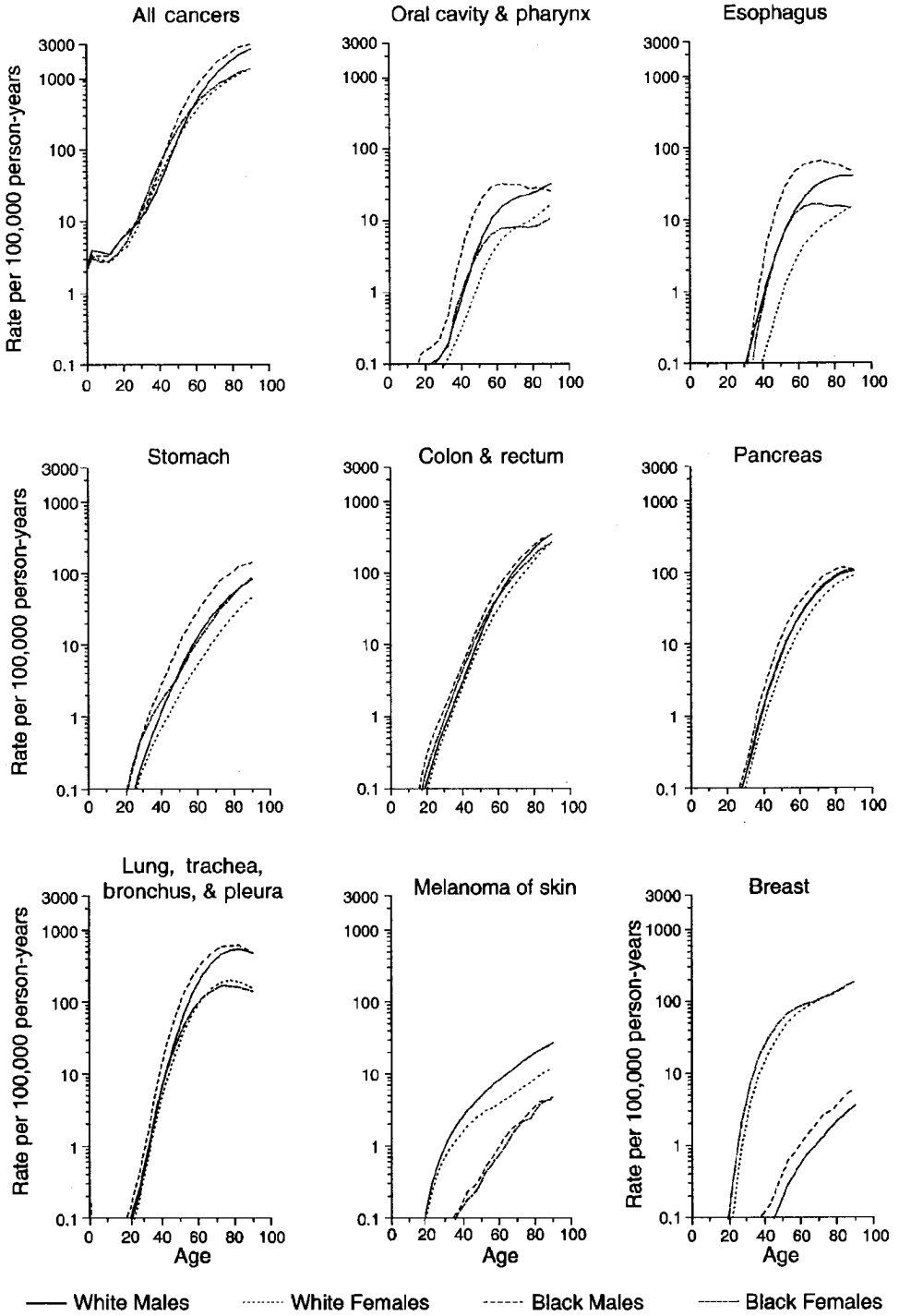

Figure 3 Age-specific mortality rates in the total U.S. population for selected cancers by race and sex, 1978–2002. *Abbreviations*: NOS, not otherwise specified; ONS, other nervous system.

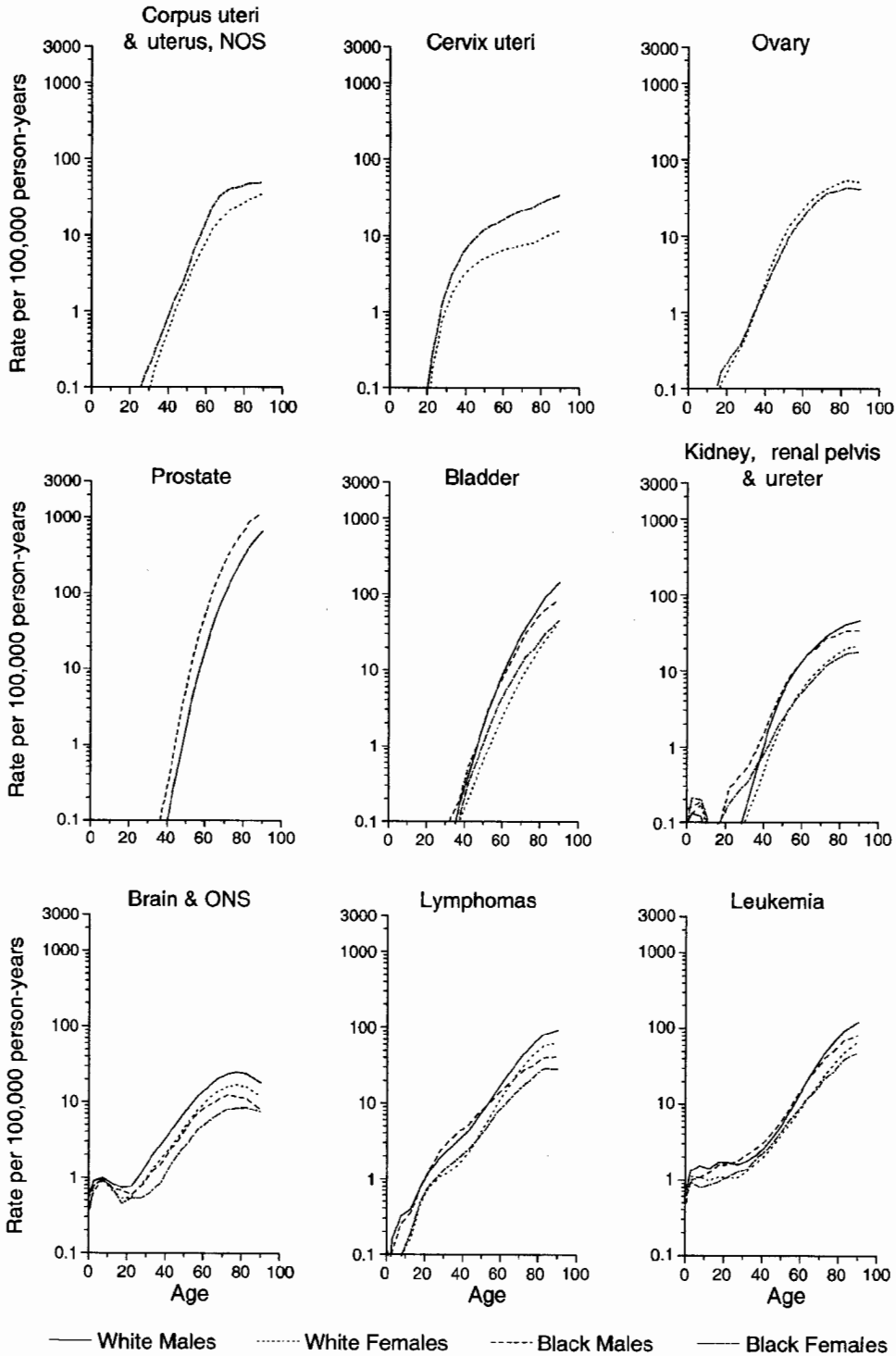

Figure 3 (*Continued*)

male excess was most pronounced at the ages of 40 years and older, with smaller differences at younger ages. Consistently higher rates among blacks than whites were evident for esophageal, stomach, cervix uteri, and prostate cancers, whereas rates among whites were notably higher for melanoma of the skin and corpus uteri cancer. Rates among young people generally were quite low, although bimodal curves were apparent for cancers of the kidney and brain, and for leukemia.

At current rates, the probability at birth of ever developing cancer is 46%, or almost one out of two, for males, and 38%, or more than one out of three, for females (Table 4) (4). At birth, the probability of dying of cancer is more than one out of five. By the age of 60, the probability of eventually developing cancer is also 46% for males, but falls to 33% for females. A male at the age of 60 years has an 18% chance of being diagnosed with prostate cancer, an 8% chance with lung cancer, and a 6% chance

Table 4 Probabilities (%) of Developing (Ever, or After Age 60) or Dying from Cancer by Type of Cancer and Sex, 2000–2002

	Males			Females		
	Developing			Developing		
	Ever	After age 60	Dying	Ever	After age 60	Dying
All cancers	45.67	45.68	23.56	38.09	32.80	19.93
Oral cavity and pharynx	1.38	1.10	0.38	0.68	0.56	0.19
Esophagus	0.76	0.72	0.74	0.25	0.24	0.22
Stomach	1.22	1.21	0.59	0.75	0.71	0.40
Colon and rectum	5.84	5.77	2.36	5.51	5.25	2.23
Liver[a]	0.89	0.76	0.65	0.43	0.39	0.37
Pancreas	1.26	1.24	1.17	1.27	1.24	1.17
Larynx	0.62	0.56	0.23	0.14	0.12	0.06
Lung and bronchus	7.58	7.74	7.25	5.72	5.39	4.92
Melanoma of the skin	1.94	1.56	0.35	1.30	0.76	0.20
Breast	0.12	0.11	0.03	13.22	9.99	2.96
Cervix uteri	–	–	–	0.74	0.34	0.26
Corpus uteri	–	–	–	2.61	2.04	0.51
Ovary	–	–	–	1.48	1.13	1.05
Prostate	17.93	18.48	2.97	–	–	–
Testis	0.36	0.02	0.02	–	–	–
Urinary bladder[b]	3.58	3.72	0.75	1.14	1.10	0.32
Kidney and renal pelvis	1.56	1.37	0.59	0.91	0.76	0.34
Brain and other nervous system	0.65	0.44	0.49	0.50	0.32	0.39
Thyroid	0.35	0.20	0.04	0.97	0.36	0.06
Hodgkin's lymphoma	0.24	0.09	0.05	0.19	0.07	0.04
Non-Hodgkin's lymphoma	2.18	1.88	0.94	1.82	1.57	0.81
Multiple myeloma	0.70	0.68	0.46	0.55	0.51	0.40
Leukemia	1.50	1.34	0.97	1.07	0.89	0.72

Note: Invasive cancer only, unless specified otherwise.
[a]Liver and intrahepatic bile duct.
[b]Urinary bladder (invasive and in situ).
–: Not applicable.
Source: From Ref. 4.

with colorectal cancer during his remaining years. A 60-year-old female has a 10% risk of breast cancer, a 5% risk of colorectal cancer, and a 5% risk of lung cancer during her remaining lifetime. At current rates, 7% of men will die of lung cancer, 3% of prostate cancer, and 2% of colorectal cancer. About 5% of women will die of lung cancer, 3% of breast cancer, and 2% of colorectal cancer.

There is considerable variation in cancer incidence and mortality rates according to racial or ethnic groups (Table 5) (25,26). The racial categories of American Indian or Alaska Native, Asian or Pacific Islander, black, and white are mutually exclusive. The ethnic category Hispanic may include any race; rate are shown for Hispanic and non-Hispanic whites. The highest total cancer incidence rate per 100,000 person-years among males during the period 1992–2002 occurred among blacks, followed by non-Hispanic whites and all whites combined, with lower rates among Hispanic whites and Asian or Pacific Islanders; the rate among American Indians/Alaska Natives was one-half of that among whites. Among females, non-Hispanic whites had the highest total cancer incidence rate, followed by all whites combined, blacks, Hispanic whites, and Asian or Pacific Islanders, with the lowest rate among American Indians/Alaska Natives.

There is also substantial international variation in cancer mortality rates (5,27). Tables 6 and 7 present age-adjusted (world standard) mortality rates during the period 1996–2000, for males and females respectively, for all cancers combined and several cancers among the elderly, defined as those aged 65 to 84 years. Among males, the rates for all cancers combined were highest in Scotland (>1500), followed by the Netherlands, Denmark, the Russian Federation, and the Republic of Korea (all >1400). Total cancer rates were lowest in Sweden, Portugal, and the

Table 5 Cancer Incidence by Racial/Ethnic Group and Sex, 13 SEER Areas 1992–2002

	Males			Females		
	Count	Rate[a]	RR	Count	Rate[a]	RR
All ages						
White	750,056	572.7	1.00	709,057	425.7	1.00
Black	91,547	715.6	1.25	74,496	401.6	0.94
American Indian/Alaska Native	4,008	285.5	0.50	4,349	229.8	0.54
Asian or Pacific Islander	60,499	394.4	0.69	60,175	301.2	0.71
Hispanic white[b]	62,753	442.6	0.77	63,527	319.8	0.75
Non-Hispanic white[b]	580,725	577.9	1.01	550,670	437.7	1.03
Ages 65 and older						
White	463,956	3014.9	1.00	397,720	1760.0	1.00
Black	47,023	3565.0	1.18	34,436	1648.5	0.94
American Indian/Alaska Native	1,917	1515.1	0.50	1,615	942.1	0.54
Asian or Pacific Islander	38,061	2189.0	0.73	26,962	1179.5	0.67
Hispanic white[b]	31,487	2431.1	0.81	24,900	1305.9	0.74
Non-Hispanic white[b]	365,409	3001.8	1.00	318,192	1792.0	1.02

[a]Per 100,000 person-years, age-adjusted using the 2000 U.S. population standard.
[b]Data for Hispanic and non-Hispanic exclude Detroit, Hawaii, Alaska Native Registry, and rural Georgia.
Abbreviation: RR, rate ratio relative to the rate among whites.
Source: From Refs. 25 and 26.

Table 6 International Variation in Mortality Rates[a] for Selected Cancers Among the Elderly (Aged 65 to 84 Years) in Selected Countries, 1996–2000: Males

	All cancers combined	Mouth or pharynx	Esophagus	Stomach	Intestines	Pancreas	Lung	Prostate	Bladder
United States	1187.1	18.2	36.4	30.3	118.3	58.0	420.9	134.2	33.2
Canada	1240.5	22.9	36.2	45.8	131.6	56.4	413.7	143.1	37.1
Denmark	1422.9	25.7	46.3	43.4	189.4	61.7	411.1	200.6	86.0
France	1330.2	47.2	52.4	53.0	143.2	56.9	323.2	142.2	56.8
Germany	1284.0	24.9	28.7	88.2	170.9	64.9	356.5	147.3	52.2
Italy	1359.8	27.6	23.5	102.8	134.5	57.3	430.6	104.2	66.2
Netherlands	1465.2	16.7	49.9	76.1	155.1	57.6	514.6	169.4	57.1
Portugal	1152.2	27.5	31.4	151.1	158.3	45.9	219.4	173.0	47.1
Russian Federation	1420.5	43.2	47.6	235.9	158.5[b]	N/A	444.7	82.3	N/A
Spain	1259.3	29.3	29.8	89.0	144.8	44.6	358.0	124.2	75.6
Sweden	1034.6	13.7	23.9	51.3	121.2	63.6	192.2	219.7	37.8
United Kingdom: England & Wales	1292.4	15.4	66.6	75.6	144.1	51.5	379.8	154.9	55.1
United Kingdom: Scotland	1512.9	23.0	86.6	78.5	177.7	55.2	513.4	151.8	58.6
Australia	1206.5	24.8	39.0	46.6	155.9	51.6	314.9	162.4	34.9
Japan	1253.4	21.2	57.2	234.1	134.9	69.8	299.6	49.9	22.1
Republic of Korea	1409.6	17.5	58.5	328.2	85.5	58.8	384.0	26.1	27.3

[a]Per 100,000 person-years, age-adjusted using the world population standard.
[b]Excluding small intestine.
N/A: Not available.
Source: From Ref. 5.

Table 7 International Variation in Mortality Rates[a] for Selected Cancers Among the Elderly (Aged 65 to 84 Years) in Selected Countries, 1996–2000: Females

	All cancers combined	Stomach	Intestines	Pancreas	Lung	Breast	Cervix uteri	Other uterus	Kidney
United States	745.8	13.8	77.5	44.1	215.1	100.3	7.4	19.7	12.4
Canada	735.9	19.4	77.3	43.6	185.5	108.2	7.2	17.5	12.7
Denmark	974.6	20.1	135.5	54.2	216.8	148.7	18.4	24.7	21.9
France	545.6	18.8	74.2	34.2	43.2	98.2	5.6	24.0	12.3
Germany	687.2	42.5	107.1	45.7	68.8	107.0	10.9	20.9	16.9
Italy	601.4	44.1	72.6	40.1	61.0	94.8	3.3	23.2	10.1
Netherlands	711.6	28.8	95.3	45.9	97.7	128.8	8.9	16.8	18.3
Portugal	521.2	67.8	78.5	27.8	29.2	78.2	8.3	25.9	7.0
Russian Federation	599.8	102.8	97.1[b]	N/A	47.1	71.0	23.0	30.4	N/A
Spain	493.9	36.2	74.6	28.8	25.7	74.5	6.3	20.4	7.9
Sweden	657.2	23.1	84.5	53.8	87.7	81.7	9.5	22.3	20.2
United Kingdom: England & Wales	795.8	28.4	86.9	39.7	170.1	118.7	10.6	16.8	12.8
United Kingdom: Scotland	941.7	39.2	99.0	41.0	261.7	116.6	13.1	14.7	15.3
Australia	647.8	18.8	92.9	40.0	110.0	86.6	9.3	12.9	15.0
Japan	500.3	74.6	69.3	40.7	66.7	25.1	8.0	11.6	4.6
Republic of Korea	507.2	116.6	48.2	32.6	82.2	10.7	12.2	17.8	4.3

[a]Per 100,000 person-years, age-adjusted using the world population standard.
[b]Excluding small intestine.
N/A: Not available.
Source: From Ref. 5.

United States (all <1200). Other countries had rates that were intermediate. These patterns were influenced by variations in the relative frequency of the various forms of cancer. Lung cancer was by far the most common cause of cancer death in every country shown except Sweden; rates ranged from greater than 500 in the Netherlands and Scotland to less than 300 in Japan, Portugal, and Sweden. Intestinal cancer mortality rates were highest in Denmark, followed by Scotland and Germany, with the lowest rates again in the Republic of Korea and the United States. Prostate cancer rates exceeded 100 in all countries except Japan and the Republic of Korea, where the rates were less than 50; rates were highest in Sweden, Denmark, Portugal, and the Netherlands. The patterns for stomach cancer were quite different, with the rate exceeding 300 in the Republic of Korea, 200 in the Russian Federation and Japan, 150 in Portugal, and 100 in Italy, in contrast to a rate of less than 50 in the United States, Denmark, Canada, and Australia. Oral cancers were most frequent in France, pancreatic cancer in Japan and Germany, and bladder cancer in Denmark, Spain, and Italy.

Among elderly females, the rates for all cancers combined were highest in Denmark and Scotland (>900), and lowest in France, Portugal, Spain, the Republic of Korea, Japan, and the Russian Federation (all <600) (Table 7). Lung cancer was the most frequent form of cancer death in the United States, Canada, Denmark, Sweden, the United Kingdom, and Australia; rates ranged from less than 30 in Spain and Portugal to more than 200 in Scotland, Denmark, and the United States. Breast cancer was the most common cancer death in the Netherlands and Germany, with rates exceeding 100, in contrast to a rate of only 25 in Japan and 11 in the Republic of Korea. Intestinal cancer was the first-ranked cancer in Germany, Spain, and Portugal; internationally, rates ranged from 48 in Korea to 136 in Denmark. The leading cancer in Korea, the Russian Federation, and Japan was cancer of the stomach, with rates of 117, 103, and 75, respectively, at least five times that in the United States. Cervix uteri cancer mortality rates were highest in the Russian Federation, Denmark, and Scotland (>13), and lowest in Italy and France (<6). Other uterine cancer rates ranged from less than 15 in Japan, Australia, and Scotland to 30 in the Russian Federation. Kidney cancer rates ranged from less than 10 in the Republic of Korea, Japan, Portugal, and Spain to more than 20 in Denmark and Sweden.

Among patients diagnosed with cancer (all forms combined) in the United States, the five-year relative survival rate, which is adjusted for expected general population mortality, ranged from 53% among black females to 66% among whites (Table 8). These rates were driven by the differing relative frequency of the major forms of cancer and varying survival rates. Survival rates were relatively high among patients diagnosed with cancers of the testis, thyroid, prostate, breast, or corpus uteri, or with melanoma. Patients diagnosed with liver, pancreas, esophagus, or lung cancer fared particularly poorly. Compared with patients of all ages, those diagnosed at the age of 65 years or older in a few instances fared better, such as those diagnosed with breast cancer, but more frequently they did less well. Differences were substantial for those diagnosed with cervix uteri, corpus uteri, ovary, or especially brain cancer, Hodgkin's lymphoma, or leukemia. Survival rates were higher among whites than blacks for most cancers. Black males diagnosed with oral, esophageal, or pancreatic cancer experienced survival rates notably lower than that experienced by the other three racial or gender groups; however, blacks with brain or other nervous system cancers or multiple myeloma had better survival experiences than whites.

The stage of disease at diagnosis varied considerably among the various solid tumors (Table 9). More than 70% of the cancers were still localized to the organ of

Table 8 Five-Year Relative Survival Rates (%) by Race, Sex, and Cancer: All Ages, Ages 65+, SEER Program, 1995–2001

	All ages				Age 65+			
	Whites		Blacks		Whites		Blacks	
	Males	Females	Males	Females	Males	Females	Males	Females
All cancers	66.5	66.3	58.4	53.2	65.0	55.8	61.2	41.9
Oral cavity and pharynx	61.1	63.1	34.3	52.0	54.8	52.0	27.4	40.6
Esophagus	16.1	16.4	8.6	11.6	13.6	14.3	2.6	6.4
Stomach	19.9	23.9	21.5	24.2	18.6	21.8	19.1	20.6
Colon and rectum	65.6	64.4	55.9	54.3	65.1	63.4	50.9	51.1
Liver[a]	7.4	10.6	5.5	4.6	3.7	6.5	6.4	N/A
Pancreas	4.7	4.2	2.9	5.6	2.9	2.8	0.9	3.9
Larynx	69.5	61.9	53.3	45.2	69.0	54.0	47.1	31.7
Lung and bronchus	13.7	17.7	11.6	15.6	12.0	15.1	10.4	12.8
Melanoma of the skin	90.3	93.5	75.7	78.2	91.5	87.5	55.1	N/A
Breast (female)	–	89.5	–	75.9	–	89.9	–	77.2
Cervix uteri	–	74.6	–	66.1	–	51.9	–	60.2
Corpus uteri	–	86.2	–	61.8	–	80.8	–	50.8
Ovary	–	44.4	–	37.7	–	28.4	–	21.4
Prostate	99.9	–	96.7	–	99.8	–	95.8	–
Testis	96.3	–	87.8	–	76.1	–	N/A	–
Urinary bladder[b]	84.3	78.6	69.7	53.9	81.8	75.5	62.5	51.8
Kidney and renal pelvis	64.7	64.5	61.8	65.9	60.4	55.6	59.9	51.1
Brain and other nervous system	32.1	33.5	37.7	37.5	4.9	6.5	5.3	8.0
Thyroid	94.4	97.7	89.2	95.4	83.6	86.9	N/A	76.6
Hodgkin's lymphoma	84.6	87.7	77.8	83.3	55.9	49.4	N/A	N/A
Non-Hodgkin's lymphoma	59.5	63.3	47.6	59.1	51.9	53.7	41.6	46.7
Multiple myeloma	35.8	28.1	36.3	30.5	27.4	22.3	35.0	23.6
Leukemia	49.6	48.4	39.2	36.9	35.7	36.8	30.2	22.8

Note: Invasive cancer only, unless specified otherwise.
[a]Liver and intrahepatic bile duct.
[b]Urinary bladder (invasive and in situ).
N/A: Not available, –: Not applicable.
Source: From Ref. 4.

origin for those arising in the corpus uteri, prostate, testis, or bladder, and for melanomas of the skin. In contrast, almost 70% of patients diagnosed with ovarian cancer, half of those diagnosed with pancreatic cancer, and 40% of those with lung cancer had distant spread of the disease at the time of diagnosis. The stage of disease strongly influenced subsequent survival. Among females diagnosed with cervix uteri cancer, the five-year relative survival rate exceeded 90% if the cancer was still localized, but it was 17% if there was distant spread; the comparable rates for females with breast cancer were 98% versus 26%, and for males with prostate cancer, 100% versus 34%.

Table 9 Stage Distribution and Five-Year Relative Survival Rates (%) by Stage of Cancer (All Races, Ages, Both Sexes) for Localized, Regional, Distant Disease, SEER Program, 1995–2001

	Stage distribution (%)			Five-year relative survival (%)		
	Local	Regional	Distant	Local	Regional	Distant
Oral cavity and pharynx	34	51	10	82.1	51.3	27.6
Esophagus	26	30	28	31.4	13.8	2.7
Stomach	24	32	32	58.0	21.9	3.1
Colon and rectum	39	38	19	90.4	67.9	9.7
Liver[a]	31	26	22	19.0	6.6	3.4
Pancreas	8	26	52	16.4	7.0	1.8
Larynx	48	45	4	83.8	49.9	18.5
Lung and bronchus	16	37	39	49.5	16.2	2.1
Melanoma of the skin	83	11	3	98.3	63.8	16.0
Breast (female)	63	29	6	97.9	81.3	26.1
Cervix uteri	55	32	8	92.4	54.7	16.5
Corpus uteri	72	16	8	96.1	66.3	25.2
Ovary	19	7	68	93.6	68.1	29.1
Prostate[b]	91	91	5	100.0	100.0	33.5
Testis	71	18	10	99.4	96.3	71.7
Urinary bladder[c]	75	19	3	94.2	48.4	6.2
Kidney and renal pelvis	53	20	22	90.6	60.3	9.7
Thyroid	58	35	5	99.5	96.4	60.0

Note: Invasive cancer only, unless otherwise specified.
[a]Liver and intrahepatic bile duct.
[b]Local and regional combined.
[c]Urinary bladder (invasive and in situ).
Source: From Ref. 4.

HEALTH BEHAVIORS AND RISK FACTORS

Changes in screening practices and lifestyle behaviors impact cancer incidence and mortality. For example, the use of screening procedures to detect early lesions is very important. The large declines in incidence and mortality rates for cancer of the cervix uteri were largely due to increasingly widespread use of the Papanicolaou (Pap) smear and pelvic examinations to detect premalignant treatable lesions (28). The proportion of white non-Hispanic women aged 45 to 64 years who had a Pap smear in the last three years rose from 71% in 1987 to 86% in 2000 (Table 10) (29). The percentages also rose among black non-Hispanic and Hispanic women, whose percentages were lower at each point in time. The screening rates were lower among women aged 65 years and older than among younger women, higher among the nonpoor than the poor, and positively associated with education. The rates increased over time in all the groups. In 2000, screening rates were also lower among women who had no contact with a primary care provider in the past year or who were unmarried (30).

In recent years, mammography screening has become more prevalent (Table 11) (29). The proportion of non-Hispanic white women aged 50 to 64 years who had a mammogram within the past two years more than doubled from 34% in 1987 to 81% by 2000. Rates among non-Hispanic black and Hispanic women were

Table 10 Trends in the Use of Pap Smears by Age Group, Racial/Ethnic Group, and Socioeconomic Group: Percent of Women 45 Years of Age and Older Having a Pap Smear in the Last Three Years

	1987	1994	2000
Ages 45–64 years			
Racial/ethnic group			
White, non-Hispanic	71.2	77.6	85.9
Black, non-Hispanic	76.2	81.9	85.7
Hispanic or Latino	57.7	70.2	77.7
Ages 65 years and older			
Racial/ethnic group			
White, non-Hispanic	51.8	58.4	64.3
Black, non-Hispanic	44.8	60.9	67.3
Hispanic or Latino	41.7	44.1	66.9
Poverty status			
Poor	33.2	44.3	53.9
Near poor or nonpoor	55.8	60.8	66.2
Education			
No high school diploma or GED	44.0	48.0	56.7
High school diploma or GED	55.4	61.4	67.0
Some college or more	59.4	66.9	69.8

Abbreviation: GED, general educational development high school equivalency diploma.
Source: From Ref. 29.

somewhat lower but also rose substantially, from 26% and 23% to 78% and 66%, respectively. Utilization rates among women aged 65 years and older generally were lower than for women aged 50 to 64 years, but mammography participation increased rapidly in all groups and exceeded 65% in each of the racial or ethnic groups in 2000. Poverty status as well as education level influenced the mammography utilization rate.

Cigarette smoking is the predominant cause of lung cancer (31,32). It also increases the risk for cancers of the larynx, oral cavity, pharynx, esophagus, kidney, urinary bladder, pancreas, and cervix uteri. The prevalence of cigarette smoking in 1965 exceeded 50% among adult males and 30% among females (Table 12) (29). Since then, the prevalence of smoking has declined to one-quarter among males and one-fifth or less among females. At each point in time, the prevalence was higher among black than white males, with small racial differences among females. Among persons aged 65 years and older, the smoking prevalence was lower than among the corresponding whole age range, 18 years and older. The prevalence declined over time among males, whereas the rates rose among females till they peaked during the mid-1980s. During 2002, the prevalence of cigarette smoking among black males was more than twice that among the other three racial/gender groups aged 65 years and older.

Although specific dietary factors are less well established as influencing cancer risk, high fruit and vegetable consumption appears to be protective for many cancers (33). Energy balance and physical activity are important, as obesity has been associated with several cancers, including those of the colorectum, corpus uteri, and (in postmenopausal women) breast. Since at least the early 1970s, the proportion of the

Table 11 Trends in Mammography Utilization by Age Group, Racial/Ethnic Group, and Socioeconomic Group: Percent of Women 50 Years of Age and Older Having a Mammogram in the Last Two Years

	1987	1990	1994	2000
Ages 50–64 years				
Racial/ethnic group				
White, non-Hispanic	33.6	58.1	67.5	80.5
Black, non-Hispanic	26.4	48.4	63.6	77.7
Hispanic or Latino	23.0	47.5	60.1	66.4
Ages 65 years and older				
Racial/ethnic group				
White, non-Hispanic	24.0	43.8	54.9	68.3
Black, non-Hispanic	14.1	39.7	61.0	65.5
Hispanic or Latino	N/A	41.1	48.0	68.2
Poverty status				
Poor	13.1	30.8	43.9	54.8
Near poor or nonpoor	25.5	46.2	57.7	69.9
Education				
No high school diploma or GED	16.5	33.0	45.6	57.5
High school diploma or GED	25.9	47.5	59.1	72.0
Some college or more	32.3	56.7	64.3	74.1

N/A: Not available.
Abbreviation: GED, general educational development high school equivalency diploma.
Source: From Ref. 29.

population that is overweight and the proportion that is obese have increased dramatically (Table 13) (29). The proportion overweight or obese is higher among black women than the other racial/gender groups; in recent years, 78% of black non-Hispanic women were overweight and 50% were obese. The proportions have been higher among Mexicans than white non-Hispanics. The percent that is

Table 12 Trends in Cigarette Smoking Prevalence (%) in the United States by Sex and Race: Ages 18 Years and Older, 65 Years and Older

	1965	1974	1985	1995	2002
Ages 18 years and older[a]					
White males	50.4	41.7	31.3	26.2	25.0
Black males	58.8	53.6	40.2	29.4	26.7
White females	33.9	32.0	27.9	23.4	21.1
Black females	31.8	35.6	30.9	23.5	18.3
Ages 65 years and older					
White males	27.7	24.3	18.9	14.1	9.3
Black males	36.4	29.7	27.7	28.5	19.4
White females	9.8	12.3	13.3	11.7	8.5
Black females	7.1	8.9	14.5	13.3	9.4

[a]Age-adjusted using the year 2000 U.S. population standard.
Source: From Ref. 29.

Table 13 Trends in Percent of the Population Aged 20 Years and Older Who Are Overweight or Obese, According to Sex, Race, and Age, United States

	Overweight[a]			Obese[a]		
	1976–1980	1988–1994	1999–2002	1976–1980	1988–1994	1999–2002
Ages 20–74 years[b]						
Males						
White, non-Hispanic	53.8	61.6	69.5	12.4	20.7	28.7
Black, non-Hispanic	51.3	58.2	62.0	16.5	21.3	27.9
Mexican	61.6	69.4	74.1	15.7	24.4	29.0
Females[c]						
White, non-Hispanic	38.7	47.2	57.0	15.4	23.3	31.3
Black, non-Hispanic	62.6	68.5	77.5	31.0	39.1	49.6
Mexican	61.7	69.6	71.4	26.6	36.1	38.9
Sex/age group						
Males						
20–34 years	41.2	47.5	57.4	8.9	14.1	21.7
35–44 years	57.2	65.5	70.5	13.5	21.5	28.5
45–54 years	60.2	66.1	75.7	16.7	23.2	30.6
55–64 years	60.2	70.5	75.4	14.1	27.2	35.5
65–74 years	54.2	68.5	76.2	13.2	24.1	31.9
75 years and older	N/A	56.5	67.4	N/A	13.2	18.0
Females[c]						
20–34 years	27.9	37.0	52.8	11.0	18.5	28.4
35–44 years	40.7	49.6	60.6	17.8	25.5	32.1
45–54 years	48.7	60.3	65.1	19.6	32.4	36.9
55–64 years	53.7	66.3	72.2	22.9	33.7	42.1
65–74 years	59.5	60.3	70.9	21.5	26.9	39.3
75 years and older	N/A	52.3	59.9	N/A	19.2	23.6

[a] Overweight: body mass index ≥ 25; Obese: body mass index ≥ 30.
[b] Age-adjusted using the 2000 U.S. population standard.
[c] Excludes pregnant women.
N/A: not available.
Source: From Ref. 29.

overweight tends to increase with age before peaking around the age of 65. In addition, heredity, past reproductive experiences in women, and the cumulative effects of environmental exposures to carcinogenic agents and chemicals in genetically susceptible individuals contribute to the risk of developing cancer.

FUTURE CHANGES IN TRENDS

The burden of cancer in the elderly will progressively increase in the early part of the 21st century due to the large number of cancers that will be diagnosed as the "baby boom" generation becomes the elderly population in the United States. One in five persons in the United States will be aged 65 years or older by the year 2030, two-thirds more than the 2000 level (34). A large segment will be from minority racial and ethnic subgroups. With increased longevity, a greater proportion of these cancers will occur in men.

Reducing the burden of cancer is a challenge. Cumulative effects over time of risk factors, genetic susceptibility, environmental exposures to carcinogens, and less healthy behaviors or practices increase the risk of cancer. However, several factors are likely to have a major effect on reducing the rates of cancer, including the reduction of smoking and increased consumption of fruits and vegetables. Behavioral change interventions to modify lifestyle habits, such as smoking and diet, and improved preventive health practices can impact cancer rates (35). Cancer is a disease of genetic alterations. Technological advancements in genetics research will make possible the identification of individuals at risk of developing cancer and will influence future trends in cancer incidence and mortality. Advancements in chemoprevention herald a new era in the primary prevention of cancer (36).

The paradigm of cancer in the elderly population is changing and will continue to shift over the next few decades. Recent data show that overall cancer mortality rates are decreasing, a most encouraging sign (37). Cancer death rates, overall, which had increased 0.5% per year during the period 1975–1990, have declined by an average of 1.1% per year since 1993. During the 1990s, mortality rates decreased in both the sexes for colon and rectum, urinary bladder, stomach, and brain cancers. The rates among males also declined for lung, prostate, and oral cancers, while rates among females decreased for breast and cervix uteri cancers, as well as for non-Hodgkin's lymphoma. Continued monitoring of the trends in cancer incidence and mortality will be needed to determine changes in the burden of cancer due to differences in cohorts, risk factors, environmental exposures, and lifestyle habits, as well as the effects of genetic screening and early detection in the aging population.

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